

DIAL/HSRL Ozone and Aerosol Profiles from the SEAC⁴RS Field Campaign

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<http://science.larc.nasa.gov/lidar>

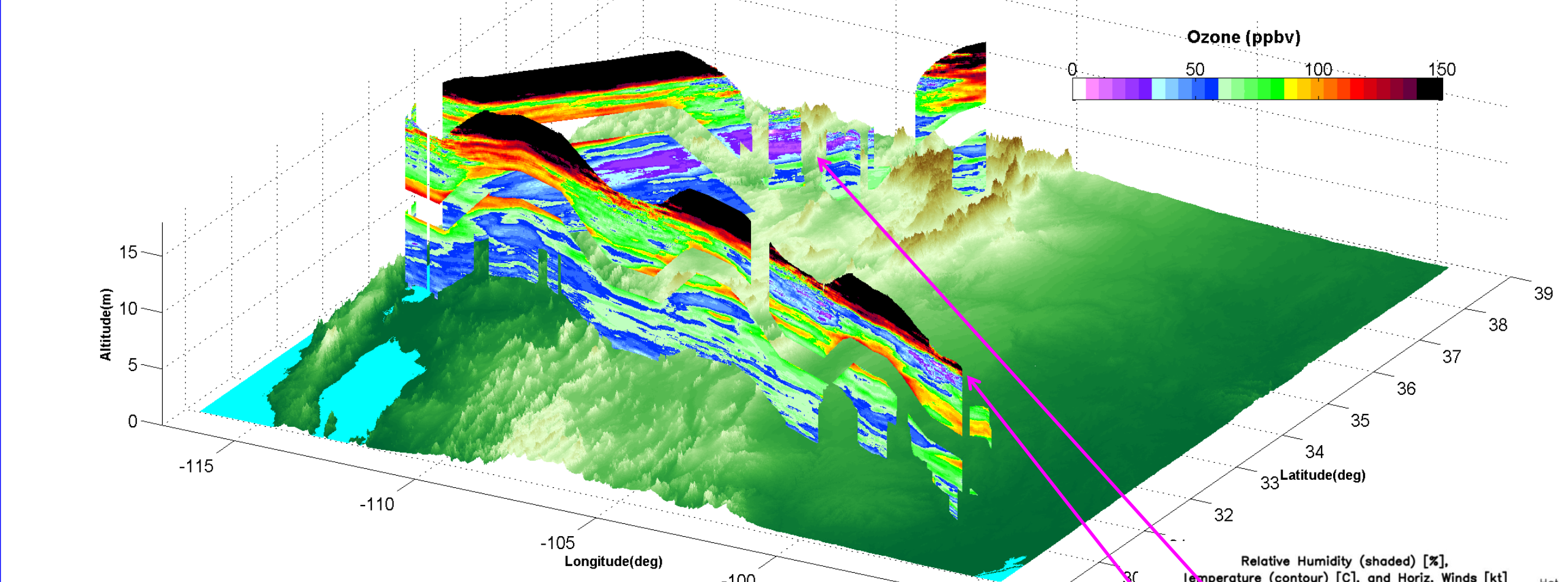


Introduction

The NASA Langley Research Center's Differential Absorption Lidar (LaRC/DIAL/HSRL) was flown aboard the NASA DC-8 and made measurements of ozone and aerosol distributions during the Studies of Emissions and Atmospheric Composition, Clouds and Climate Coupling by Regional Surveys (SEAC4RS) field experiment. DIAL remote profile measurements of ozone were made from near the surface to above the tropopause along the flight track of the DC-8. In addition, new High Spectral Resolution Lidar capabilities enable measurements of aerosol backscatter, (532, 1064nm), extinction (532nm), and depolarization (355, 532, 1064nm), to characterize the aerosol and cloud distributions.

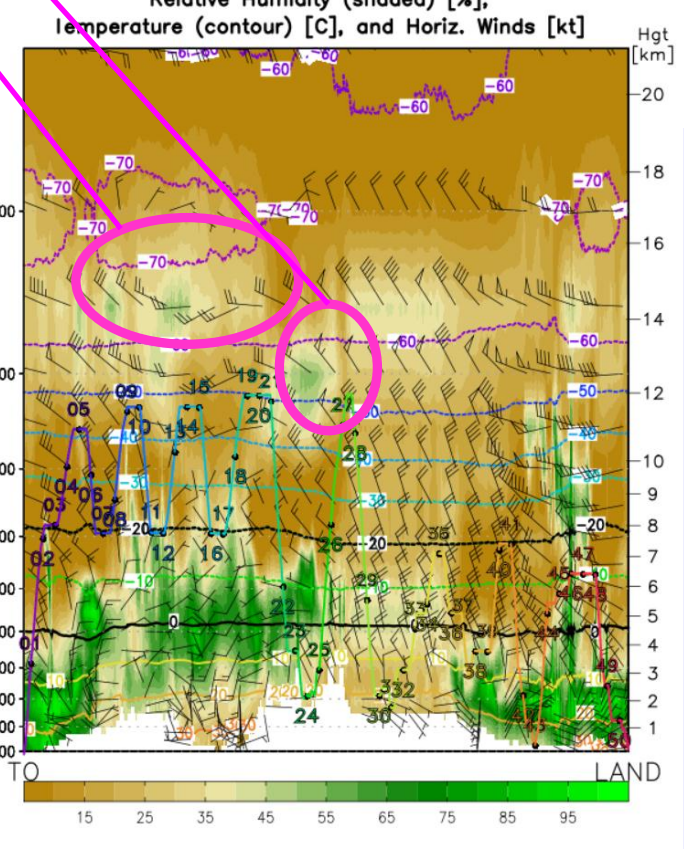
DIAL/HSRL measurements are presented for a few of the SEAC4RS flights. These show the high variability of the ozone that was observed in the upper troposphere and lower stratosphere (UTLS) associated with the North American Monsoon (NAM). Examples of derived aerosol products such as aerosol depolarization, spectral depolarization, lidar ratio, and aerosol backscatter color ratio highlight differences in various aerosol types. Examples of several analysis products are also shown: cloud heights (boundaries), Mixed Layer Heights, Aerosol Optical Depth (AOD) and aerosol typing.

North American Monsoon (NAM)



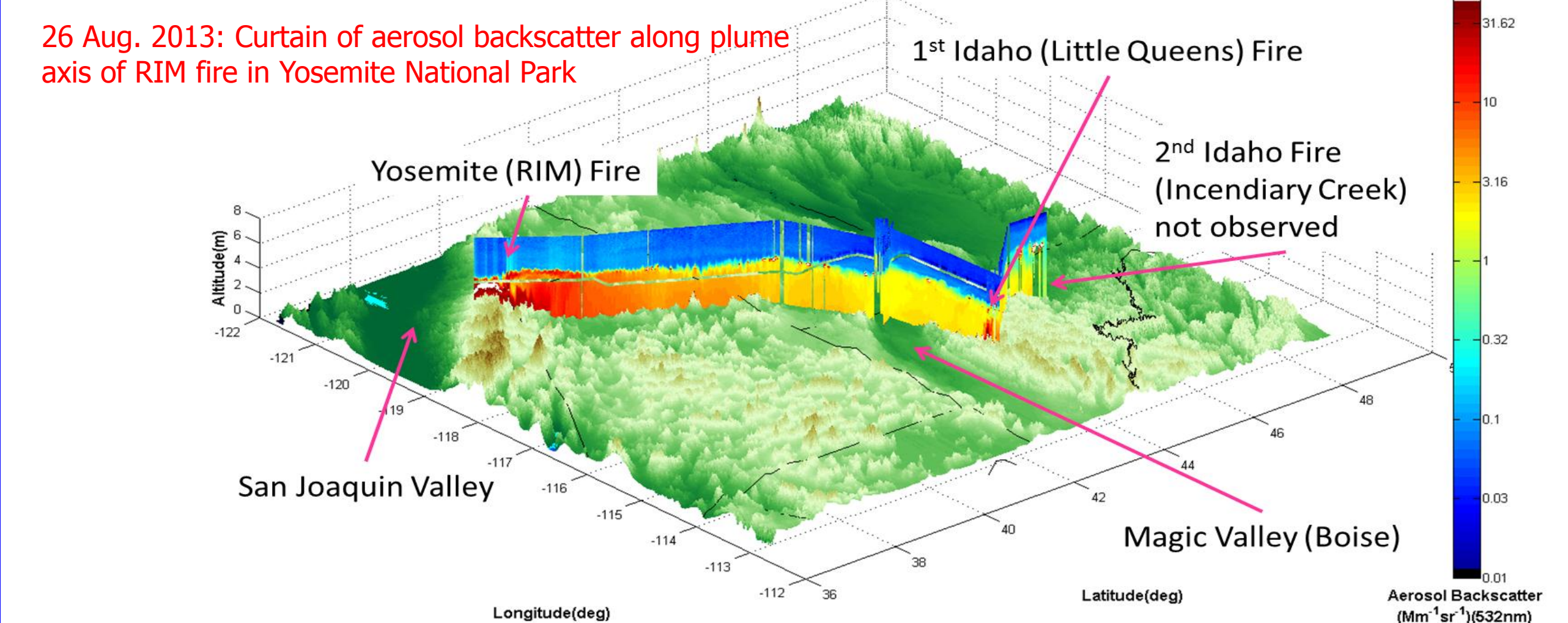
16 August 2013

- DIAL measurements made during a flight from Houston to S. California can be used to map the ozone and aerosol horizontal and vertical gradients in the upper troposphere associated with NAM circulation and convective transport.
- Low ozone (30 ppbv) observed at 13-14 km east of the Rocky Mtns and over SW US on the NE leg (at 7-10 km) is consistent with a clean marine source associated with recent convection (i.e. low ozone and lower aerosol backscatter.)
- Note that these low ozone regions are correlated to enhanced RH near the tropopause from the WRF model (H. Fuelberg) as shown in the image at right.
- In contrast, enhanced ozone filaments are observed throughout the upper troposphere from 6-15 km and are correlated with enhanced aerosol scattering (not shown) compared to the low ozone regions.
- Similar features were observed on the transit flight shown in right hand set of figures. (Aug 8, 2013)



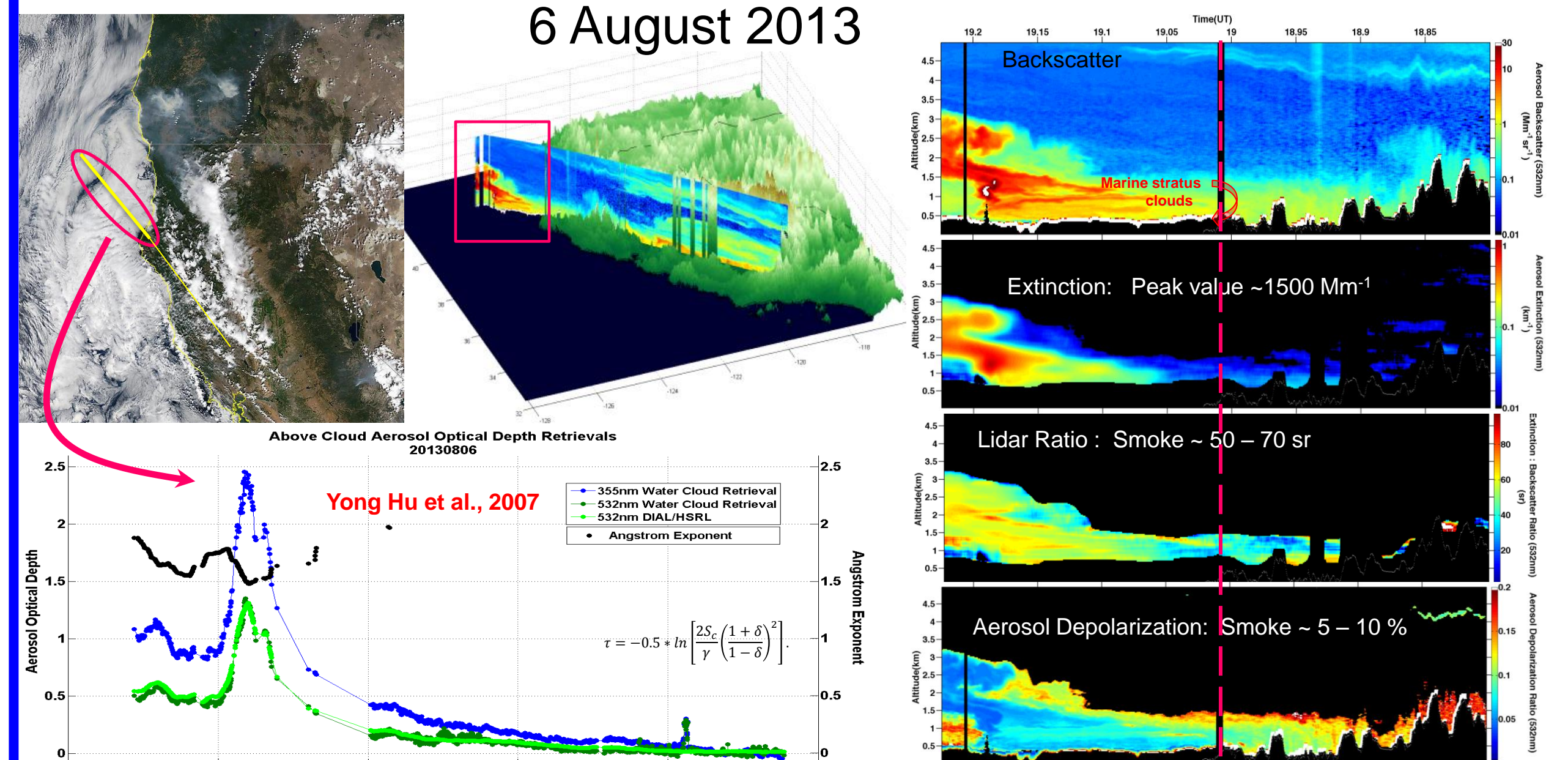
Fire/Smoke Plumes

26 Aug. 2013: Curtain of aerosol backscatter along plume axis of RIM fire in Yosemite National Park



Above Cloud AOD Retrieval Assessment

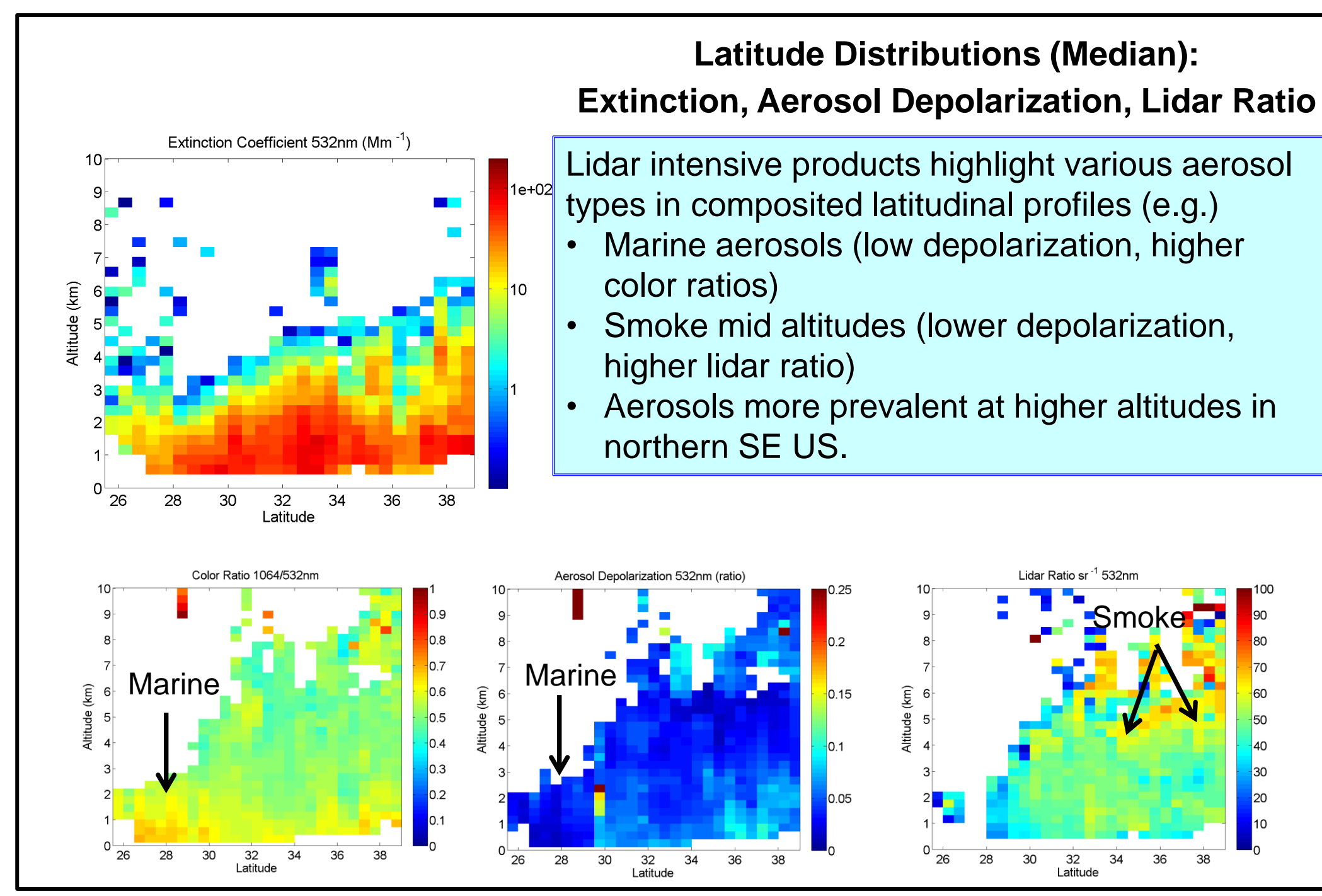
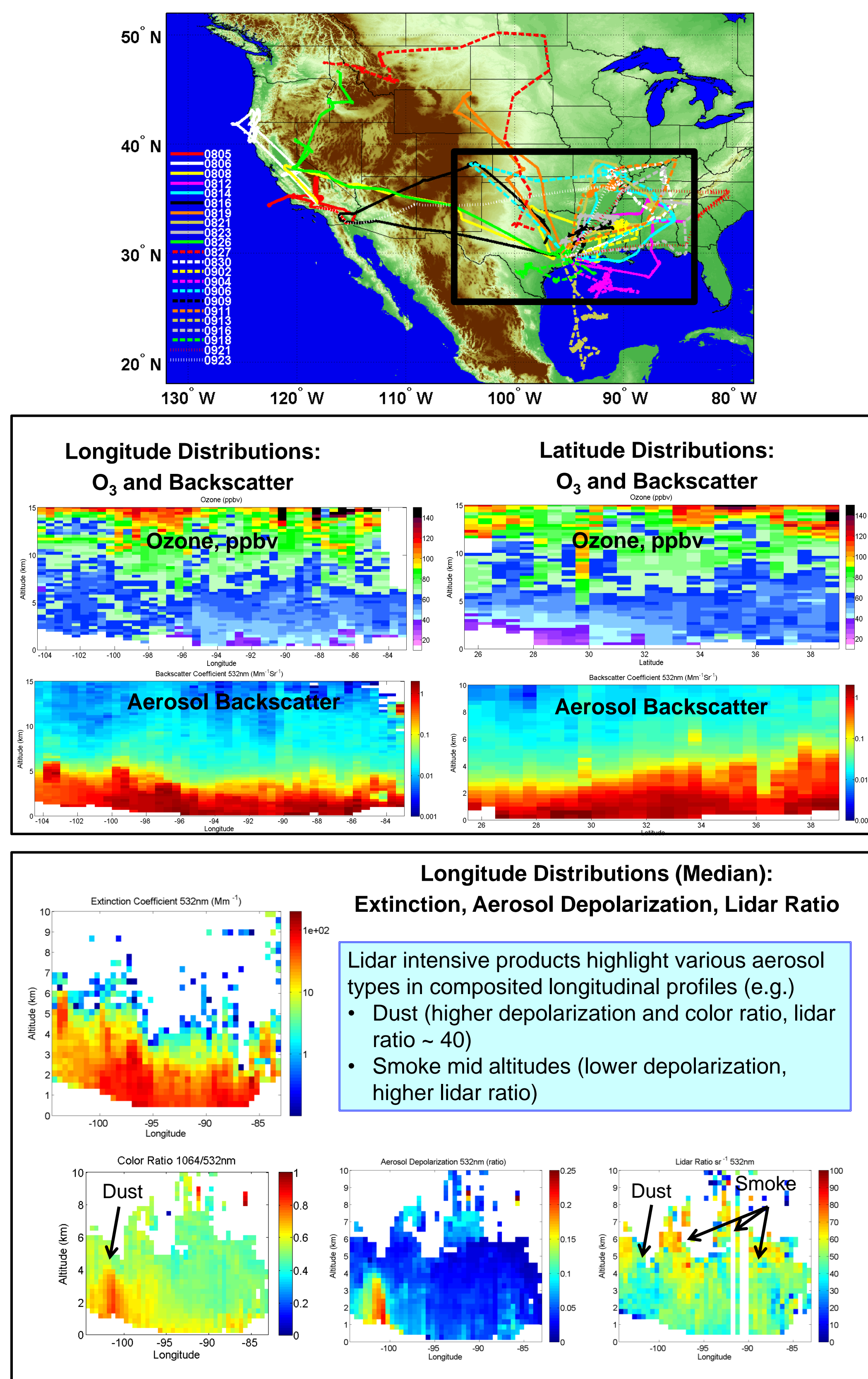
6 August 2013



Case study to assess accuracy of ACAOD retrievals from CALIOP

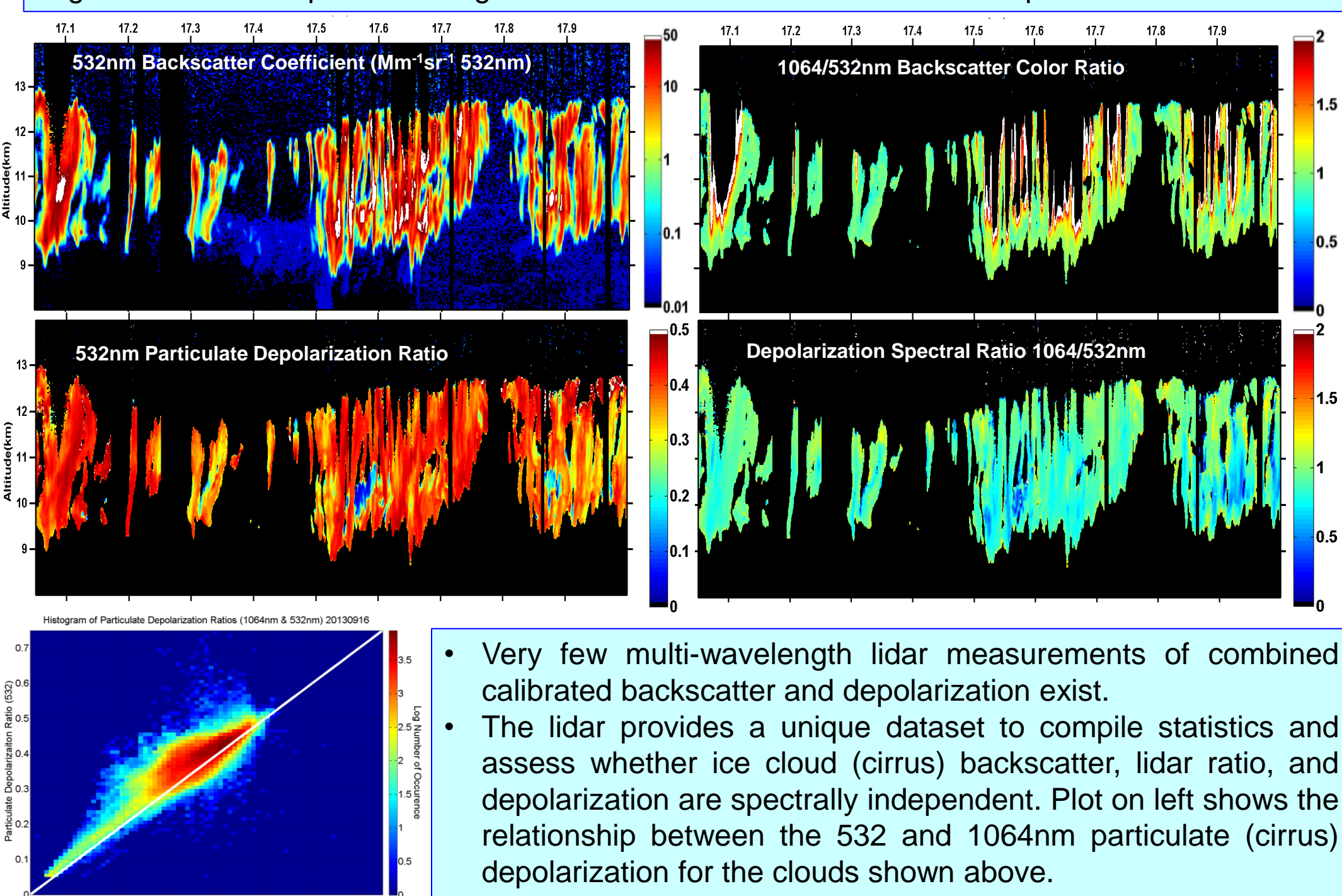
- Oregon/Washington smoke sampled off coast over stratus clouds. Provides excellent dataset to evaluate lidar retrievals.
- Using integrated attenuated backscatter (γ), the integrated depolarization (δ), and an estimated lidar ratio for the clouds $S_{\text{ext}}=19.3$ based on previous estimates, the AOD optical depth can be retrieved over opaque clouds. (Yong Hu et al., 2007)
- Roughly 1/3 of CALIOP returns end in opaque clouds, allowing this retrieval method to be applied.
- Multiwavelength backscatter and depolarization measurements allow retrievals of AOD and Angstrom Exponents that can be assessed by other remote and in situ measurements during the smoke transect.

Composited lidar distributions: 25 – 39 N; 105 – 83 W



Cirrus Clouds: 3-wavelength measurements

SEAC4RS provides a dataset to assess multi-wavelength lidar measurements to investigate correlations and sensitivities to ice cloud microphysics and assess how these impact the current CALIOP and future (CATS-ISS, AT-LID) data retrievals. Example shown here shows measurements of the backscatter, depolarization, and color ratio of ice clouds along flight segment from 16 Sept 2013 along the Gulf Coast from Houston to Florida panhandle.



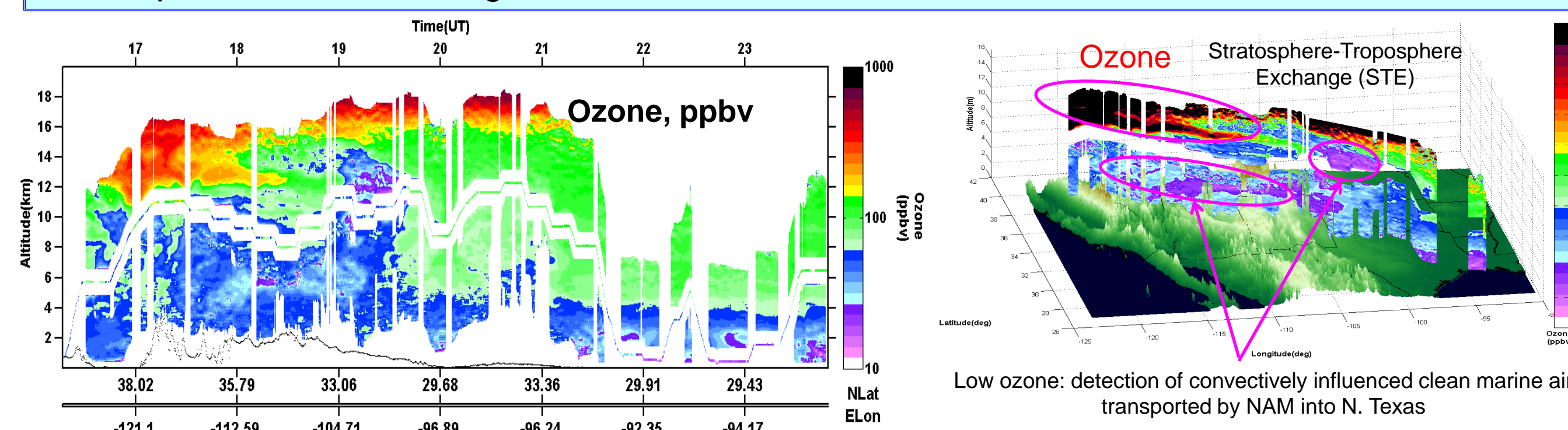
DIAL/HSRL Data Products

Transit Palmdale to Houston 08-Aug-2013

Differential Absorption Lidar (DIAL) Measurements

Ozone Mixing Ratios

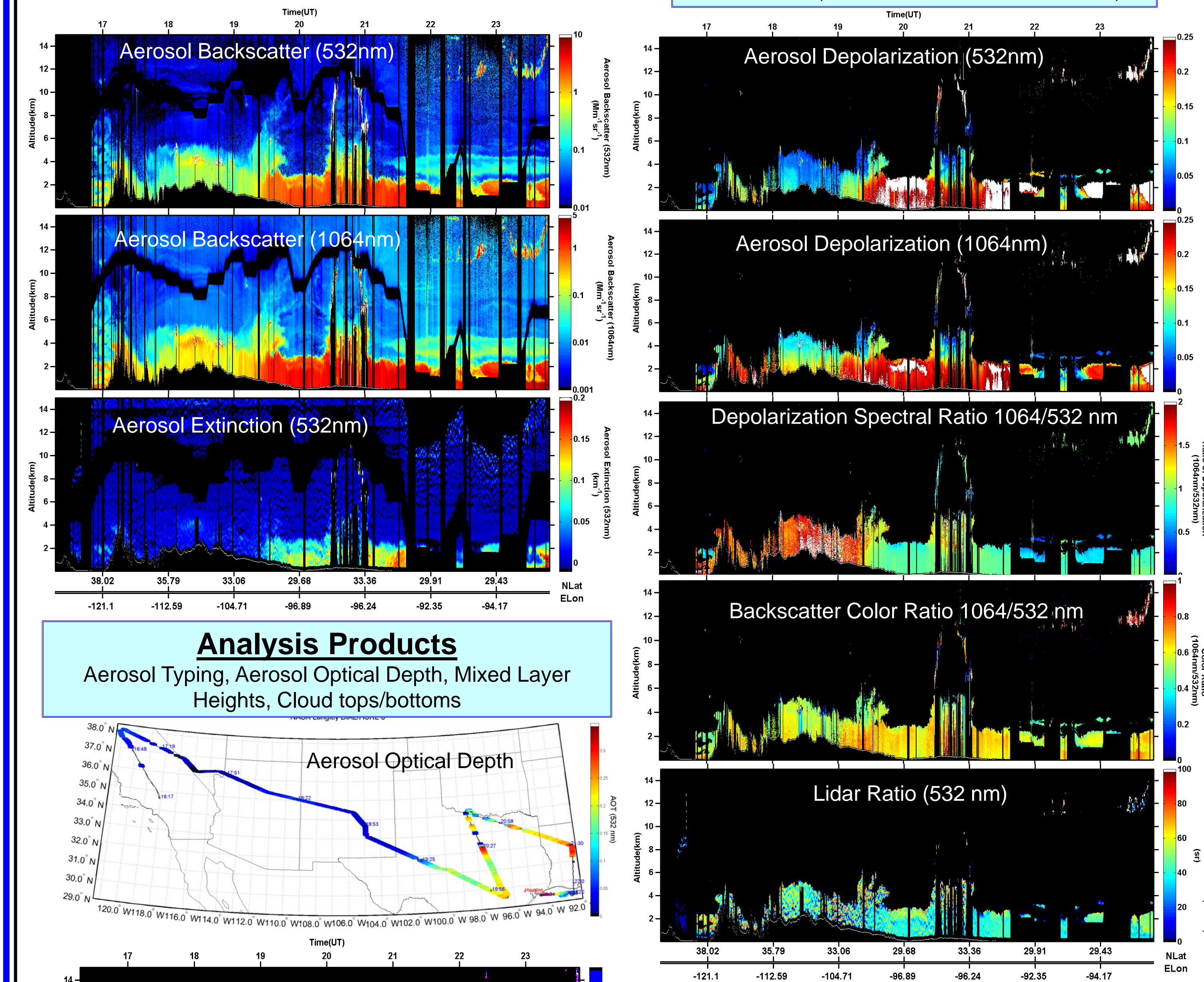
- Ozone profiles were measured from near the surface to the UT/LS.
- Ozone profiles are averaged 3min and 270m vertically.
- In-situ ozone measurements from NOAA's Chemiluminescence instrument (T. Ryerson) are plotted on DIAL images at aircraft altitude.



High Spectral Resolution Lidar (HSRL) Measurements

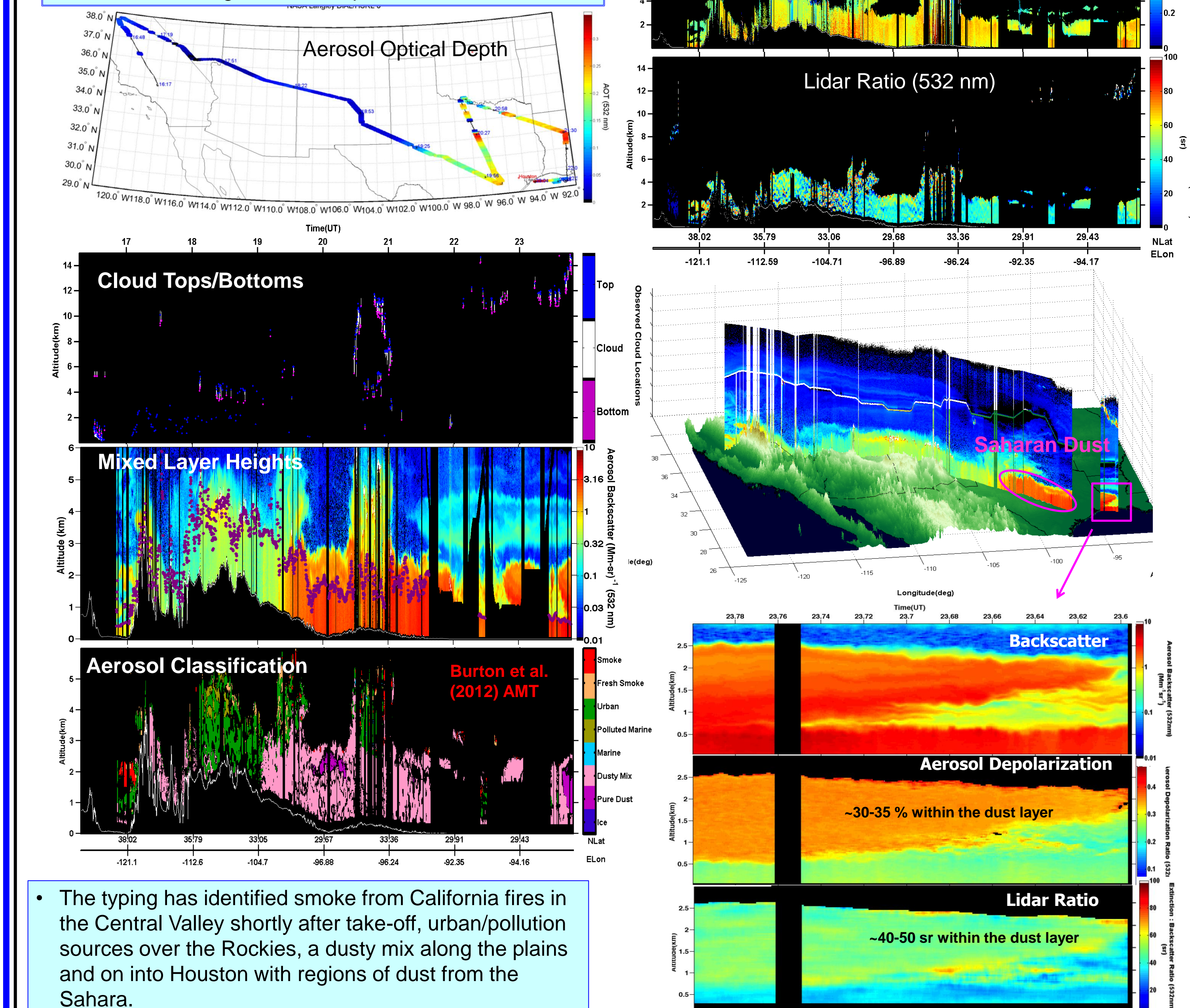
Extensive Parameters
(Depend on particle type and concentration)
Aerosol Backscatter
Aerosol Extinction

Intensive Parameters
(Depend on particle composition, size, shape)
Aerosol Depolarization
Depolarization Spectral Ratio
Backscatter Color Ratio
Lidar Ratio (Extinction-to-Backscatter Ratio)



Analysis Products

Aerosol Typing, Aerosol Optical Depth, Mixed Layer Heights, Cloud tops/bottoms



- The typing has identified smoke from California fires in the Central Valley shortly after take-off, urban/pollution sources over the Rockies, a dusty mix along the plains and on into Houston with regions of dust from the Sahara.
- Transport of and sampling of Saharan dust layer provided excellent case to evaluate remote sensors and their retrievals onboard the ER-2.
- Case provides lidar data of intensive properties (depolarization and lidar ratio) important in CALIOP retrieval assessments.
- Note the differences in optical properties in the dust and marine layer. It is evident that the dust has mixed into the marine boundary layer based on the elevated depolarizations in this region.

Acknowledgements:

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